

GROWTH AND INSTABILITY IN DRYLAND AGRICULTURE OF ANDHRA PRADESH

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ABSTRACT

This paper examines the growth and instability in area, production, yield and also components of output growth of major dryland crops before (1974-1993) and after (1993-2013) the initiation of economic reforms in Andhra Pradesh. Growth rates were estimated by fitting semi-log trend equation. Cuddy Della Valle index was used to measure the instability. Contribution of area and yield towards production growth was made through decomposition. The comparison of production and acreage growth rates in two periods revealed that maize, bengal gram, castor, tobacco, onion and chilli performed better in the second period where, maize, bengal gram and castor registered above 10% growth in production. Growth rates of yields revealed that jowar, bajra, maize, horse gram, groundnut, castor, safflower, cotton, chilli and coriander performed better in the second period. The instability index would show that higher production instabilities were observed in all the crops with the exception of Jowar, ragi, onion and chillies during the second period. The source of output growth is area in case of paddy, jowar, maize, ragi, bengal gram, green gram, horse gram, safflower, and coriander during the second period. The contribution of yield is observed in black gram, groundnut, castor, sugarcane, tobacco, onion, and chilli whereas, area and yield together influenced the output in the case of bajra, red gram and cotton.

KEYWORDS: Andhra Pradesh, Dryland, Growth, Instability, Decomposition

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INTRODUCTION

Dry land farming is occupying 47% (UNEP, 1992) and 56% (Singh and Venkateswarlu, 2009) area of arable land in the world and India, respectively. Dryland agriculture accounts for 53% of total cropped area, where, 48% of the area is under food crops and 52% under non-food crops (MoA, 2008). The contribution of dry land agriculture to total food grain production is about 40% and supports two-thirds of livestock population in India. The predominant crops in dry lands include cereals 85%, pulses 85%, oil seeds 70% and cotton 65% mostly cultivated by small and marginal farmers.

In India, nine states (Rajasthan, Madhya Pradesh, Maharashtra, Gujarat, Chhattisgarh, Jharkhand, Andhra Pradesh, Karnataka and Tamil Nadu) account for over 80% of the dry lands. In Andhra Pradesh (new) dry land area accounts for 53.4% of total cropped area where, 50.54% is accounted for by the three districts *i.e.*, Ananthapur (22.05%), Kurnool (17.39%) and Prakasam (11.10%). In the present study, these three districts together considered as dryland area of Andhra Pradesh and nineteen major crops were identified for analysis which accounted for 88% of the total cropped area in 2012-13 (TE).

Objectives of the Study

- To examine the trend in area, production and productivity of identified crops and hence, the pattern of growth in dry land agriculture of Andhra Pradesh.
- To examine the sources of output growth, the magnitude and instability in identified crops.

DATA AND METHODOLOGY

The selected districts had diversified cropping pattern and hence all important food crops and cash crops were selected for the study. The data on area, production and productivity of selected crops were collected from various publications of Govt. of Andhra Pradesh namely Statistical Abstracts and Season and Crop Reports. The present study conducted in dry land area pertains to the period from 1973-74 to 2012-13. The study period was split up into two sub periods *viz.*, Period I: 1973-74 to 1992-93, period II: 1993-94 to 2012-13. Second period coincides with economic reforms and agricultural liberalization.

Estimation of Growth in Area, Production and Yield

Compound growth rates were estimated with the following exponential model.

$$Y = ab^t$$

Where,

Y = Area, Production or Yield of the crop

a = constant

b = coefficient to be estimated

t = the time period

$$CGR(r) = (b-1) \times 100$$

Where,

CGR (r) = compound growth rate in percentage

The growth rates were tested for their significance by using the students 't' test.

Instability

Variation can be measured by coefficient of variation, but the simple coefficient of variation overestimates the level of instability in time-series data characterized by long term trends whereas, the Cuddy-Della Valle index corrects the coefficient of variation. Instability in area, production and productivity was estimated to examine the extent of risk in those variables using Cuddy-Della Valle Index (Cuddy and Della Valle, 1978) which is given as,

$$\text{Cuddy-Della-Valle-Instability-Index}(\%) = CV \cdot (1 - R^2)^{0.5}$$

Where,

R^2 = ESS/TSS i.e. ratio of explained variation to total variation.

CV = coefficient of variation in per cent, and

R^2 = adjusted coefficient of determination from a time trend regression

Decomposition Analysis

To measure the relative contribution of area and yield towards increased production of the crops concerned, the following methodology was used.

$$\Delta P = A_0 \cdot (Y_n - Y_0) + Y_0 \cdot (A_n - A_0) + \Delta A \cdot \Delta Y$$

Where,

ΔP = Change in the production

A_0 = Area in the base year

Y_0 = Yield in the base year

A_n = Area in the current year

Y_n = Yield in the current year

ΔA = Change in the area ($A_n - A_0$)

ΔY = Change in the yield ($Y_n - Y_0$)

Where the first term indicates productivity contribution, second term indicates area contribution and last term indicates interaction effect.

RESULTS AND DISCUSSIONS

Cropping Pattern of Major Crops

There has been a major decline in the area cultivated under total cereals and millets and increase in the area cultivated under pulses and oil seeds during the recent period. Around 56.5% of the gross cropped area of the dryland was under total cereals & millets during 1973-74. This has been drastically declined to 16.5% in 2012-13 (Table 1). Major gain in area was observed in groundnut followed by bengal gram. Though the share of groundnut in gross cropped area declined during 2012-13, it could still constitute around 32.3%.

The average area under maize, bengal gram, red gram, green gram, black gram, groundnut, castor, onion and chilli has increased during the second period. The average area under jowar, bajra, ragi, horse gram, safflower, cotton, sugarcane, tobacco and coriander has been declined (Table 2). Thus there is a change in the cropping pattern towards the cultivation of maize, bengal gram, red gram, black gram, groundnut, castor, cotton, onion and chilli and these are the major players of growth during the second period.

Growth Rates of Area, Production and Productivity of Major Crops

The growth analysis would indicate the general pattern of growth and direction of changes in the yield and area. The growth rates of area, yield and production of all selected crops in dryland agriculture of Andhra Pradesh are presented

in Table 3 to 5. The area under the paddy was stagnant while the area under the millets (sorghum, maize, pearl millet and finger millet) declined in both the periods with the exception of maize (Table 1), which had a significant positive growth in both the periods. This was in tune with the national trend as reported by Bhalla and Singh (2001) and Kubo (2006) and also with the state trend as reported by Rama Rao *et al.*, (2008).

Among the pulses, bengal gram showed a significant gain in area (13.9%), while in case of oilseeds castor area grew significantly (9.58%) during the second period. Groundnut, an important oil seed crop gained area during the first period due to the fillip provided by the Technology Mission on Oilseeds but lost area in the second period. This was probably due to cheaper import of edible oils, as the government eased restriction on imports. This was in tune with the state trend as reported by Rama Rao *et al.*, (2008). Among the commercial crops tobacco gained area during the second period, while in case of spices, the area is coming down mainly due to the decline in the area under chilli and coriander due to the absence of incentives for cultivation of spices.

Growth rate of area of total cereals & millets was negative in both the periods. Total oil seeds lost area in the second period due to the decline in the area of groundnut and safflower. Total pulses gained area in the second period. It is due to National Food Security Mission (NFSM), launched in the state from Rabi 2007-08 with the objective of increasing production and productivity of Rice and Pulses on a sustainable basis to ensure food crops security.

Table 1: Relative Share of Major Crops in Gross Cropped Area

Crop	1973-74	1983-84	1993-94	2003-04	2012-13
Rice	9.7	10.9	9.7	4.4	6.2
Jowar	22.0	16.7	8.1	6.3	4.2
Bajra	5.2	5.1	1.6	1.7	1.6
Maize	0.0	0.1	0.4	0.9	3.4
Ragi	2.2	1.8	0.8	0.3	0.1
Bengal gram	0.2	0.6	1.9	10.4	15.4
Red gram	1.8	2.2	3.1	5.9	6.0
Green gram	0.4	0.3	0.7	1.8	0.2
Black gram	0.1	0.1	0.5	0.7	1.3
Horse gram	3.7	2.6	0.4	0.2	0.1
Groundnut	17.7	25.7	42.6	33.9	32.3
Castor	1.2	1.0	1.0	1.0	3.7
Safflower	0.3	0.7	0.3	0.1	0.0
Cotton	7.4	6.0	5.3	3.0	9.2
Sugarcane	0.2	0.2	0.2	0.0	0.1
Tobacco	4.1	2.9	2.5	2.8	2.9
Onion	0.2	0.2	0.3	0.5	0.8
Chillies	0.8	0.8	1.1	1.3	1.4
Coriander	2.0	4.3	2.4	1.0	0.3
Total area	79.3	82.3	83.2	76.3	89.4
Minor millets	17.2	12.2	2.5	0.8	0.8
Total Cereals & Millets	56.5	47.3	23.2	21.0	16.5
Total pulses	6.3	6.0	6.8	13.1	23.3
Total food grains	62.9	53.2	30.1	34.1	39.8
Total oil seeds	19.9	28.5	52.2	48.1	38.6

Source: compiled from various volumes of statistical abstracts and season and crop reports of Andhra Pradesh.

Note: The data presented here pertains to the years that had experienced more or less normal rainfall.

Table 2: Average Area under the Major Crops in Dry Land Agriculture

Crop	Area (L ha)		Per Cent Change
	1973-74 to 1992-93	1993-94 to 2012-13	
Rice	2.58	2.59	0.39
Jowar	4.23	1.36	-67.85
Bajra	1.11	0.32	-71.2
Maize	0.03	0.28	833
Ragi	0.46	0.1	-78.26
Bengal gram	0.15	2.34	1460
Red gram	0.59	1.26	113.56
Green gram	0.1	0.23	130
Black gram	0.07	0.28	300
Horse gram	0.58	0.06	-89.66
Ground nut	6.44	10.05	56.1
Castor	0.26	0.38	46.15
Safflower	0.12	0.03	-75
Cotton	1.54	1.31	-14.94
Sugarcane	0.04	0.01	-75
Tobacco	0.78	0.75	-3.85
Onion	0.05	0.15	200
Chillies	0.24	0.33	37.5
Coriander	0.76	0.32	-57.9

Source: compiled from various volumes of statistical abstracts and season and crop reports of Andhra Pradesh.

Among the millets, the gain in yield growth rate was the highest in maize (4.9%) followed by jowar (4.21%) and bajra (3.35%) during the second period (Table 2). There was a slowdown in the yield growth in case of paddy. Among the pulses bengal gram showed low and stagnant growth in the yield. The gain in growth rate was observed in horse gram (3.91%). Among the oil seed crops the gain in the growth rate was highest in castor (6.21%) followed by safflower (5.82%) whereas, groundnut showed marginal increase in the growth rate. Among the commercial crops the gain in growth rate was highest in cotton (11.41%) followed by tobacco (3.34%). Among the spices the gain in growth rate was highest in case of chilli (7.27%) followed by coriander (6.36%) though there is decline in area.

Table 3: Compound Growth Rates of Area of Dry Land Crops

Crop	1973-74 to 1992-93	1993-94 to 2012-13
Paddy	-0.80	0.05
Jowar	-4.79***	-3.72***
Bajra	-4.92***	-2.72
Maize	13.94***	9.90***
Ragi	-5.97***	-9.83***
Bengal gram	7.57***	13.9***
Red gram	4.43***	3.35***
Green gram	1.51	-4.22
Black gram	12.90***	2.08
Horse gram	-10.23***	-5.58**
Groundnut	3.62***	-0.88
Castor	0.29	9.58***
Safflower	3.45	-16.83***
Cotton	-1.86	-3.34
Sugarcane	-8.02***	-7.38***
Tobacco	-3.28**	1.48
Onion	4.19***	6.24***

Table 3: Contd.,		
Chilli	3.28***	0.83
Coriander	2.56	-12.45***
Minor millets	-8.19***	-8.86***
Total Cereals & Millets	-3.91***	-1.46***
Total pulses	-0.11	7.97***
Total food grains	-3.44***	2.25***
Total oil seeds	4.81***	-0.17

***Significant at 1%; ** Significant at 5%; *Significant at 10%

Table 4: Compound Growth Rates of Yield of Dry Land Crops

Crop	1973-74 to 1992-93	1993-94 to 2012-13
Paddy	2.78***	1.78***
Jowar	3.81***	4.21***
Bajra	0.72	3.35**
Maize	1.84	4.88***
Ragi	1.16***	-1.36
Bengal gram	2.46	2.44
Red gram	1.78	-1.51
Green gram	1.63	-1.67
Black gram	5.02***	-0.88
Horse gram	-0.26	3.91**
Groundnut	1.12	1.67***
Castor	1.60	6.21***
Safflower	1.77	5.82***
Cotton	2.33	11.41
Sugarcane	-0.61	-0.44
Tobacco	-0.01	3.34***
Onion	0.81	0.56
Chilli	2.01	7.27***
Coriander	-1.25	6.36***
Minor millets	1.40	-0.24
Total Cereals & Millets	2.89***	3.99***
Total pulses	2.22	4.52***
Total food grains	2.54***	2.03***
Total Oilseeds	-0.53	-2.88

*** Significant at 1%; ** Significant at 5%; *Significant at 10%

Growth rates of yield of total food grains showed declining trend in the second period whereas, that of total cereals and millets and total pulses showed increasing trend.

Table 5: Compound Growth Rates of Production of Dry Land Crops

Crop	1973-74 to 1992-93	1993-94 to 2012-13
Paddy	2.08	1.51
Jowar	-1.24	0.92
Bajra	-3.77***	0.27
Maize	15.49***	13.72***
Ragi	-4.67***	-9.44***
Bengal gram	9.3***	17.41***
Red gram	5.80***	4.49
Green gram	3.31	-5.44
Black gram	14.03***	2.21
Horse gram	-9.24***	-2.30

Table 5: Contd.,		
Groundnut	4.28***	-4.85
Castor	0.92	15.64***
Safflower	5.29	-11.99***
Cotton	1.01	-1.86
Sugarcane	-8.31***	-0.10
Tobacco	-1.81	5.39***
Onion	0.05***	6.83***
Chilli	5.36***	8.16***
Coriander	1.28	-0.07***
Minor millets	-6.90***	-9.08***
Total Cereals and Millets	-1.14	2.48***
Total pulses	2.11	12.85***
Total food grains	-0.99	4.32***
Total Oil seeds	4.25***	-3.05

*** Significant at 1%; ** Significant at 5%; *Significant at 10%

During the second period the production of paddy decreased due to decrease in the growth rate of yield. This is in tune with the state trend reported by Rama Rao *et al.*, (2008). Among the millets the annual growth rate of maize is 13.72% as against 15.49% in the first period. This is predominantly due to decline in the area sown to this crop. Jowar and bajra showed positive growth rates but, less than one per cent growth per annum. This positive growth rate in the production is due to increase in the yield. The growth in the production of ragi is negative due to decline in the area and yield. Rapidly changing food habits in favour of fine cereals like rice and wheat (Kumaret *al.*, 2007) and non-inclusion of coarse cereals in the PDS (Rama Rao *et al.*, 2008) are quoted as major reasons for this drastic trend. Among the pulses bengal gram recorded highest growth rate (17.41%). This is predominantly due to expansion in the area which is intern due to the availability of short duration, high yielding wilt resistant varieties, good and less fluctuating market price. The rate of decline in the production of red gram, green gram, black gram is due to decline in the growth rate of both area and yield. In case of oil seeds the production of castor is encouraging due to yield and area expansion. Growth rate of production of groundnut and safflower were negative due to decline in the area.

Among the commercial crops the production of tobacco is encouraging due to the yield and area expansions. The decline in the production of cotton and sugarcane is due to fall in the area sown to these crops. In case of spices, production of chilli and onion are encouraging. This is predominantly due to the growth of yield and area respectively. During the first period maize and black gram showed production growth rate of above 10 per cent per annum but, in the second period maize, bengal gram, castor showed above 10 per cent growth. This is because of increase in area under the maize and bengal gram whereas yield in case of castor. Total cereals & millets, total pulses and total food grains gained in the production during second period. Though there is fall in the area, the yield growth contributed to the production in total cereals & millets.

Decomposition Analysis

The results of the decomposition analysis were presented in the (Table 6). Area was found to be the major contributor in case of paddy (236.93%), jowar (780.22%), maize (228%), ragi (91%), bengal gram (93%), green gram (165%), horse gram (133%), safflower (49%) and coriander (49%) during the second period. The contribution of productivity is observed for black gram (278%), groundnut (92%), castor (1292%), sugarcane (56%), tobacco (61%), onion (283%) and chilli (233%) whereas; area and yield together influenced the output in the case of bajra (228%), red gram (260%) and cotton (458%).

Instability

The magnitude and instability in area, production and yield was worked out and the results were presented in the (Table 7). Higher production instability was observed in maize (108.91%) during first period but, it has been reduced to 56% during the second period. Red gram showed higher yield instability during the second period (102.52%). Most of the crops showed higher production instabilities in both the periods. The instability has been divided into two categories i.e. low instability if the Cuddy Della Valle index is less than 30 and high instability if it is greater than 30. During the second period Maize, green gram, black gram, horse gram, castor, cotton and sugarcane showed higher instability in area whereas, red gram, green gram, castor, safflower and cotton showed higher yield instabilities. High production instability was observed in fifteen crops out of the nineteen identified crops. Only in case of jowar, ragi, onion and chilli the production instability was low. The production instability in paddy, bajra, groundnut and castor was low during the first period but, turned to be high during the second period.

Table 6: Decomposition of Output Growth in Selected Crops (Per Cent)

Crop	Effect in period 1973-74 to 1992-93				Effect in period 1993-94 to 2012-13			
	Area	yield	Interaction	Total	Area	yield	Interaction	Total
Paddy	-16.13	84.07	32.06	100	236.93	-2.62	-134.31	100
Jowar	292.87	-164.56	-28.31	100	780.22	-612.3	-67.92	100
Bajra	141	-1	-40	100	-63	-65	228	100
Maize	48	28	24	100	89	9	2	100
Ragi	162	-62	0	100	91	19	-10	100
Bengal gram	62	26	12	100	93	12	-5	100
Red gram	62	78	-40	100	22	-182	260	100
Green gram	-32	26	106	100	165	58	-123	100
Black gram	37	0	63	100	13	278	-191	100
Horse gram	72	41	-13	100	133	60	-93	100
Groundnut	66	30	4	100	-16	92	24	100
Castor	35	-90	155	100	-1179	1292	-13	100
Safflower	221	105	-226	100	49	42	9	100
Cotton	-317	284	133	100	-490	132	458	100
Sugarcane	251	-12	-139	100	49	56	-5	100
Tobacco	153	45	-98	100	18	61	21	100
Onion	20	83	-3	100	-177	283	-6	100
Chilli	10	60	30	100	-10	233	-123	100
Coriander	1213	499	-1612	100	49	39	12	100
Minor millets	131	-19	-12	100	143	37	-80	100
Total cereals and millets	732	-1216	584	100	29	92	-21	100
Total pulses	-2	79	23	100	-269	507	-138	100
Total food grains	2163	-3428	1365	100	-35	163	-28	100
Total oil seeds	67	19	14	100	34	82	-16	100

Table 7: Instability in Area, Production and Productivity of Dry Land Crops

Crop	1973-74 to 1992-93			1993-94 to 2012-13		
	Area	Production	Yield	Area	Production	Yield
Paddy	11.78	19.69	10.15	23.68	30.94	9.18
Jowar	10.55	21.63	15.09	17.28	22.91	15.60
Bajra	14.19	27.33	21.45	28.54	44.69	28.89
Maize	94.63	108.91	29.10	37.21	55.97	23.92
Ragi	9.82	12.33	6.25	14.44	18.53	14.21
Bengal gram	21.99	55.33	27.53	20.04	30.32	21.16

Table 7: Contd.,

Red gram	12.47	40.89	35.21	21.57	47.18	102.52
Green gram	32.48	43.78	31.16	53.52	61.43	32.06
Black gram	38.98	46.79	16.43	51.05	49.70	17.92
Horse gram	21.88	35.57	32.03	45.58	70.74	27.98
Groundnut	12.17	26.36	15.30	10.89	49.37	18.86
Castor	16.67	24.05	44.59	68.89	68.06	39.09
Safflower	33.86	41.50	31.04	27.80	41.82	41.27
Cotton	23.99	51.08	29.88	44.62	48.53	51.73
Sugarcane	35.19	42.37	8.55	59.62	51.46	19.18
Tobacco	26.47	38.56	15.76	26.16	30.78	12.26
Onion	17.62	22.06	23.65	15.06	19.26	15.48
Chillies	15.48	29.68	26.77	18.96	25.01	14.27
Coriander	34.81	33.86	49.95	25.95	37.17	23.09
Minor Millets	21.45	31.13	25.63	33.83	57.83	31.15
Total cereals & millets	7.88	15.02	13.80	7.59	11.20	8.16
Total pulses	8.44	32.30	27.82	13.76	29.01	24.36
Total food grains	6.90	15.00	13.59	6.44	12.99	8.91
Tot oilseeds	14.89	26.09	22.61	9.44	45.02	39.73

Cuddy Della Valle index low instability (<30), High instability (>30)

CONCLUSIONS

The comparison of production and acreage growth rates in two periods revealed that the maize, red gram, green gram, black gram, groundnut, safflower and coriander performed better in the first period where maize and black gram registered above 10% growth during the first period. Growing demand for maize as poultry feed and for other industrial uses resulted in a favourable price situation for the crop. However this crop showed declining trend in the second period due to fall in the area sown to this crop but constituted above 10% growth due to increase in the yield. The production of black gram dropped from 14.03% in the first period to 2.21% during the second period. This is due to decline in the area and yield. During the second period bengal gram, castor, tobacco, onion and chilli performed better where, maize, bengal gram and castor recorded above 10% growth in production. This is due to increase in area in case of bengal gram whereas increase in area and yield in case of castor. Growth rates of yields revealed that paddy, ragi, red gram, green gram and black gram performed better in the first period while that of jowar, bajra, maize, horse gram, groundnut, castor, safflower, cotton, chilli and coriander performed better in the second period.

The instability index would show that higher production instabilities were observed in all the crops with the exception of jowar, ragi, onion and chilli during the second period.

In case of paddy, jowar, maize, ragi, bengal gram, green gram, horse gram, safflower, and coriander the output growth is due to area effect during the second period. Yield is key source in black gram, groundnut, castor, sugarcane, tobacco, onion, and chilli whereas, area and yield together influenced the output in the case of bajra, red gram and cotton.

The share of total cereals and millets in GCA has been declined from 56.5% during 1973-74 to 16.5% in 2012-13. There is a change in the cropping pattern towards the cultivation of maize, bengal gram, red gram, black gram, groundnut, castor, cotton, onion and chilli during the second period. The production instability in these crops should be reduced and yield should be improved by developing wilt resistant, short duration, location specific high yielding varieties. There is urgent need to regain the area under the total cereals and millets by providing subsidies and incentives to the farmers.

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